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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/017,262	12/14/2001	David L. Adler	P960	6094

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11/06/2002

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EXAMINER

JOHNSTON, PHILLIP A

ART UNIT

PAPER NUMBER

2881

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/017,262

Applicant(s)

ADLER ET AL.

Examiner

Phillip A Johnston

Art Unit

2881

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 9-15,36-57,61,62 and 66-69 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 9-15,36-57,61,62 and 66-69 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 14 December 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 6.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). ____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

Detailed Action

Claims

1. Claim 68 is rejected due to its dependence on Claim 58, which was cancelled via preliminary amendment received 8/13/02

Claims Rejection – 35 U.S.C. 103(a)

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 9-15, 36-57, 61, 62, 66-69 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,317,514 to Reinhorn, in view of Todokoro, U.S. Patent No. 6,310,341, in further view of Ose, U.S. Publication No. 2001/0010357.

Regarding claims 9-15, 36-40, 43-51, and 57. Reinhorn describes a method that comprises irradiating a spot of the wafer surface with a beam having a wavelength sufficiently shorter than the working function of the metal, such as deep UV beam, collecting the electrons released by the irradiated wafer, generating an electrical signal that is a function of the collected electrons, and inspecting the signal to determine whether any non-conductive material is present on said spot of the wafer, and particularly, if said spot comprises contact holes or vias, whether the contact holes or

Art Unit: 2881

vias within the irradiated wafer spot are open. See Column 4, line 1-14. It is implied herein that by selecting a light source that would excite photoelectrons from non-conductive materials and not excite metals, the method of the Reinhorn invention is equivalent to "increase the difference in photoelectron yield between at least two of said materials", as recited in Claims 11,37, and 43. It is also implied herein that the Reinhorn photon energy selection process is equivalent to "identifying the chemical composition of said defect on the basis of the photon energy at which said photon yield increases substantially", as recited in Claim 57. Although the Reinhorn invention uses a DUV (deep ultraviolet) light source to generate photoemission from the wafer surface, where, it should be appreciated that other short wavelength light sources can be used. Specifically, laser light has been generally preferred because its spatial coherence ("polarized photons" as recited in Claims 14,15, 46 and 47) permits creating a small beam spot on the substrate. See Column 4, line 61-67, and Column 5, line 1-10. The light beam 24 is focused by objective 25 to form a spot on the wafer surface. Vacuum chamber 20 also contains an electron detector shown at 27, which has an opening for the passage of the light beam issuing from objective 25. Numeral 40 schematically indicates an optional biased electrode. It is preferable to have the light source 22 outside the vacuum chamber 20, and to allow the beam 24 to enter the chamber via window 28. Then the beam can be made to impinge upon the scanner 23. In operation, the beam is made to scan the wafer covering strips having a width determined by the scanning angle of the scanner 23 and length determined by the travel of the stage in a first direction, say in the Y direction. It is implied herein, that the scanning angle of the

Art Unit: 2881

Reinhorn invention can be varied to include an angle of "90 degrees or less", as recited in Claims 12, 13, 44 and 45. Once the beam completes scanning one strip, the stage moves in the second direction, say the X direction. As the light beam impinges upon metal at the bottom of a contact hole or via, electrons are emitted and detected by the detector 27. On the other hand, if the contact hole or via is fully blocked, the energy of the impinging light beam would be insufficient to cause electron emission; so that an alarm can be issued that the contact hole is blocked or missing. Similarly, when the contact hole is partially blocked fewer electrons will be emitted, and a corresponding signal, provided by the detector 27 so that an alarm may be issued. The investigation of the signal can be done using methods such as a threshold, or any suitable algorithm for die-to-die, or a cell-to-cell comparisons, etc. In a similar manner, when inspecting the substrate for metal residue or similar defects, the wafer can be scanned to locate electron emission from areas where there should be only an insulator. For example, when the scan is performed in the trenches 130 of the insulator part 105, no electrons should be emitted. If electrons are emitted, it signals that there's metal residue inside on an insulating layer and a defect alarm should be issued. See Column 5; line 29-67, and Column 6, line-1-6. Reinhorn also teaches that when the electrons are pulled from the wafer, a positive potential may be left on the wafer. This phenomenon is known in the art as "charging effect". In order to avoid this charging effect, an electron gun is optionally placed in the vacuum chamber in order to direct electrons to areas that are already scanned in order to keep the wafer neutral, as recited in Claims 36 and 48. See Column 6, line 40-48. Although Reinhorn discloses, a wafer defect detection and

Art Unit: 2881

classification method based upon irradiation with a photon source, Reinhorn does not teach the use of an imaging process in the method. Todokoro; however, discloses a projection type imaging method wherein an electron beam 116 accelerated by an electron gun 102 enters into a separator 104 through a lens 103 and a deflection system 110. A magnetic field H in a direction normal to the plane of the figure is applied to the separator 104. Therefore, the electron beam 116 is deflected, thereby, directed to a sample 101 through an objective lens 117. A negative voltage is applied to the sample. Therefore, the electron beam 116 is decelerated between the sample 101 and a cathode lens 115. By the deceleration, energy of the electron beam 116 with which the sample 101 is to be irradiated is adjusted below 100 eV. An electron beam 118, backscattered by the sample 101 is accelerated by the cathode lens 115, and enters in the separator 104 through the objective lens 117. Since the traveling direction of the electron beam 118 is opposite to that of the electron beam 116, the electron beam 118 is deflected to the direction opposite to the electron gun 102 by the separator 104. The deflected electron beam 118 is magnified by an intermediate lens 106 and a projective lens 107, and imaged on a surface of an MCP (a multichannel plate image intensifier) 108. The electron image amplified by the MCP 108 accelerated toward a fluorescent screen 109, to form on the fluorescent screen 109, the two-dimensional optical image is observed on an image tube 119. Although the above explanation is on the case where back-scattered electrons are imaged, it is possible to observe secondary electrons by irradiation electrons from an auxiliary electron gun 114 onto the sample 101 from an oblique direction and accelerating the generated secondary electrons using the cathode

Art Unit: 2881

lens 115. In addition, numeral 112 designates a halogen lamp. When sample 101 is irradiated with the light from the halogen lamp it excites electrons, the "photoelectrons" as recited in Claim 9, and the excited electrons are projected to form an image. See Column 3, line 9-45. It is implied herein that the photon and electron sources of the Todokoro invention are utilized to "concurrently or alternately expose the substrate", as recited in Claims 38,39,49,and 50. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the wafer inspection method and apparatus of Reinhorn with the imaging process of Todokoro to provide an image of the wafer during the wafer inspection process. The resultant images of the surface would allow expanded defect detection capabilities in semiconductor manufacturing processes, particularly the identification of shape, location and composition of conductors and insulators relative to standards desired.

Regarding Claims 41,42, 52-56, 61,62, 66-69. Reinhorn in view of Todokoro, as applied to Claims 9-15,36-40,43-51, and 57 above discloses a method for imaging a substrate that includes nearly all the limitations of Claims 41,42, 52-56, 61, 62, 66-69, but does not disclose the use of angular dependent energy filtering as a means of discriminating between backscattered and photoemission electrons. Ose; however discloses an energy filter, based on the angle electrons are reflected and emitted from the substrate surface, that includes a cathode 4, which emits electrons when a beam voltage 6 is applied across the cathode 4 and an emission control electrode 5. The electrons thus emitted, are accelerated (decelerated in some cases) by emission control electrode 5 and an anode 8 held at a ground voltage. It is implied herein that the above

Art Unit: 2881

described acceleration or deceleration capability of the Ose invention is equivalent to providing both "an influx of relatively high-energy, or low-energy electrons", as recited in Claims 61,66 and 69. In addition, an acceleration voltage for accelerating a primary electron beam 1 is equal to an electron gun acceleration voltage 7. The primary electron beam 1, accelerated by the anode 8, is gathered by a condenser lens 9. A secondary electron detector, may be interposed between the energy filter 60 and the objective 10 to catch all the secondary electrons that collide against the meshes of the energy filter 60 and do not reach the conversion electrode 16. When there is not any retarding electric field or the retarding electric field is sufficiently small, only the reflected electrons pass the electron beam passing aperture of the objective 10. The reflected electrons have high energy. Positions at which the reflected electrons fall on the conversion electrode 16 are dependent on angle at which the electrons are reflected by the specimen 13 and energy of the reflected electrons. Therefore, information represented by the selected reflected electrons can be obtained in a high sensitivity by disposing an aperture filter 62 below the conversion electrode 16 with respect to the traveling direction of the primary electron beam. When the reflected electrons reflected in a substantially perpendicular direction are selected, an image of high contrast of a specimen having a specific atomic number can be observed in a high resolution. See Page 3, paragraph 0031, and 0032. It is implied herein, that the ability to utilize the angular dependent, energy filter method of Ose described above is equivalent to "selective detection of low-energy electrons, high-energy electrons, photoelectrons, reflected electrons, specular, and/or scattering effects" as recited in Claims 41,52-56,

Art Unit: 2881

61,62, and 66-69. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the wafer inspection method and apparatus of Reinhorn in view of Todokoro as applied above, with the energy filter method of Ose, to provide improved resolution of surface topography as well as the ability to identify surface composition. In so doing, the Reinhorn in view of Todokoro, in further view of Ose, invention can be used to quickly define the shape and composition of wafer surface defects, resulting in more rapid identification of defect types, leading to faster resolution of quality, "root cause" issues, and a resulting higher semiconductor production throughput.

Conclusion

4. Any inquiry concerning this communication or earlier communications should be directed to Phillip Johnston whose telephone number is (703) 305-7022. The examiner can normally be reached on Monday-Friday from 8:00 am to 5:30 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiners supervisor John Lee can be reached at (703) 308-4116. The fax phone numbers are (703) 308-2864 and (703) 308-7721.

PJ
October 21, 2002


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